

Republic of Kenya

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KS 2110-4 (2009) (English): CCTV surveillance systems for use in security applications – Part 4: Installation, planning and implementation requirements (Draft Standard)



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**CCTV surveillance systems for use in security applications —
Part 4: Installation, planning and implementation requirements**

PUBLIC REVIEW DRAFT, MARCH 2009

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Securicor Alarms (K) Ltd.
Department of Defence
Ministry of Roads and Public Works
Kenya Power & Lighting Company Ltd.
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Foreword

This Kenya Standard was developed by the Technical Committee on Extra-low Voltage and is in accordance with the procedures of the Bureau.

In the preparation of this Kenya Standard reference was made to SANS 10222-5-1-3:2007.

Acknowledgement is hereby made for assistance derived from this source.

PUBLIC REVIEW DRAFT

CCTV surveillance systems for use in security applications – Part 4: Installation, planning and implementation requirements

1 Scope

This part of Kenya Standard gives recommendations for the planning and installation of closed circuit television (CCTV) equipment comprising of camera(s) with monitor(s), video recorder(s), switching control and ancillary equipment for use in security applications.

The objectives of this part of Kenya Standard are:

- a) To provide guidance to the installers of CCTV systems with respect to the pre-installation (or planning) phase and the physical on-site installation phase;
- b) To provide an overview of the external environmental factors that need consideration during installation of the CCTV system, that could affect its operational performance;
- c) To provide an overview of the installation documentation requirements; and
- d) To provide an overview of the testing, commissioning and hand-over phase of the installation.

2 Normative references

The following standards contain provisions that, through reference in this text, constitute provisions of this part of Kenya Standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this part of Kenya Standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards can be obtained from the Kenya Bureau of Standards.

KS 2110-1- *Installation and remote monitoring of detector activated CCTV systems- code of practice*

KS 2110-2 – *CCTV surveillance systems for use in security applications – Operational requirements.*

KS 2110-3– *CCTV surveillance systems for use in security applications – System design requirements.*

KS 2110-5– *CCTV surveillance systems for use in security applications – Testing, commissioning and handover requirements.*

KS 2110-6– *CCTV surveillance systems for use in security applications – Maintenance requirements.*

3 Definitions and abbreviations

3.1 Definitions

3.1.1

CCTV camera

Unit containing an imaging device producing a video signal from an optical image

3.1.2

CCTV camera equipment

Unit containing a CCTV camera plus appropriate lens and necessary ancillary equipment

3.1.3

CCTV control unit

Equipment for controlling and monitoring the required operational functions of the CCTV system

3.1.4

CCTV surveillance installation

Installation consisting of the hardware and software components of a CCTV system, fully installed and operational for

3.1.5

CCTV surveillance system

System consisting of camera equipment, monitoring and associated equipment for transmission and controlling purposes, which may be necessary for the surveillance of a defined security zone

3.1.6

Operational requirement

Statement of needs based on a thorough and systematic assessment of the problems to be solved and the hoped-for solutions

3.2 Abbreviations

3.2.1 CCTV	: Closed circuit television.
3.2.2 dB	: Decibel.
3.2.3 RF	: Radio frequency.
3.2.4 SPD	: Surge protection device.
3.2.5 UPS	: Uninterruptible power supply.
3.2.6 VCR	: Videocassette recorder.
3.2.7 VHS	: Video home system.

4 Planning or pre-installation phase

4.1 General

This phase of the installation identifies various items that need to be considered before the actual physical installation of the CCTV equipment. The different types of items that need to be examined will very much depend on the size and scope of the project. For example, a small project will require very little planning consideration, whereas a larger project will require detailed planning. The operational requirements and the design requirements of the CCTV system should have been clearly defined before the installation, planning and implementation phase commences.

4.2 Miscellaneous considerations

4.2.1 Operational requirements

4.2.1.1 The operational requirement development process encourages clear thinking about the what, where, when, why and by whom of a CCTV surveillance system. The operational requirement document shall clearly state what the end-user expects from the system. Without an operational requirement document and associated test procedures, there will be no guarantee that the system will meet its intended purpose.

4.2.1.2 An operational requirement document shall provide a statement of needs based on a thorough and systematic assessment of the problems to be solved and the resultant desired solutions, provide guidance on writing operational requirement check-lists, and finally, illustrate how to apply the end-user's needs in terms of the acquisition, installation and management of a CCTV surveillance system (See 4.2.3.2).

4.2.2 System design requirements

4.2.2.1 While many of the technical issues can be defined, the provision of high quality pictures will be of no value if they are of the wrong scene or if they are not seen by the observer. Many people who purchase camera systems, fall into the trap of believing that they are buying a simple alarm system when they are actually buying a sophisticated command and control system. Whatever the original thoughts, careful analysis reveals a mix of security, safety and management needs. When designing the system, therefore, it is important to recognize all the issues that are involved in a system.

4.2.2.2 Some or all of the following design criteria are taken into account when a quality CCTV surveillance installation is designed:

- a) Determination of the zones or objects requiring surveillance;
- b) Determination of the number of cameras and their locations, required to monitor the agreed zones or

objects;

- c) Evaluation of existing lighting and consideration of new or additional illumination;
- d) Selection of cameras and equipment depending on the operating environmental conditions;
- e) Control point configuration;
- f) Power supplies;
- g) Determination of functional and operating procedures; and
- h) Maintenance.

4.2.3 Installation documentation

4.2.3.1 In general, sufficient documentation should be created to allow for the identification of all cables, their routing, type and purpose. Although the level of documentation will depend on the complexity of the individual system, it should be sufficient for the correct operation, safe maintenance and future expansion of the system.

4.2.3.2 It is advisable to open an installation (or project) file, which could include some or all of the following documents:

- a) Original system proposal request;
- b) Approval or authorization of request;
- c) Formal order from client;
- d) Technical specifications;
- e) General conditions of contract;
- f) Any special conditions of contract;
- g) Bills of quantity;
- h) Works information;
- i) work schedule;
- j) Component (or item of equipment) information;
- k) Appropriate statutory requirements;
- l) Test acceptance and commissioning certificates; and
- m) hand-over certificate.

4.2.3.3 Irrespective of the type of information required for the planning and implementation of the CCTV surveillance installation, the principle of concise, complete and unambiguous information should apply.

4.2.4 Security clearance, induction and medical requirements

4.2.4.1 Some clients, such as mining houses or certain parastatal organizations, may require that all site staff associated with the installation get security clearance before the work commences. The particular clearance procedures will, in all probability, vary from client to client and may well take some time, depending on the security level required. The minimum information required will normally be full names, addresses and identification details. Staff members may also be required to wear an identification badge whilst on site.

4.2.4.2 In addition to security clearance requirements, large organizations (mining houses in particular) may also require staff to attend a site induction course, in order to acquaint themselves with the safety and working regulations applicable to the particular site.

4.2.4.3 Before the staff are allowed on site, they may be required to undergo a medical examination, to ensure they are fit enough to work in certain specialized environments.

4.2.5 Safety clothing and equipment

4.2.5.1 Examples of safety clothing and equipment that could be required at a specific site, are given below:

- a) Hard hat;
- b) Safety shoes with steel toe caps;
- c) Protective gloves;
- d) Safety harness – when working on scaffolding or extreme heights;
- e) Protective overalls;
- f) Simple face masks; and
- g) Respiratory masks.

4.2.5.2 Conditions at some sites may be more severe than at others, necessitating the use of intrinsically safe clothing. In these circumstances, the client's Health and Safety department will provide guidance and advice on the requirements.

4.2.6 Tools and test equipment

4.2.6.1 Installation staff should have access at site to the following minimum equipment:

- a) Ladder – appropriate to the working height, with access to a scaffold tower in difficult circumstances;
- b) Large and small pair of steps;
- c) Tool box containing:
 - Selection of screwdrivers (Philips, Posidrive, Terminal)
 - Combination pliers (insulated)
 - Side cutters (insulated)
 - Wire strippers
 - shifting spanner
 - Selection of suitable spanners
 - Hacksaw and blades
 - Stanley knife
 - Large and small hammers
 - set of Allen keys
 - Spirit level
 - Plumb line– crimping tool(s)
 - Soldering iron(s)
 - Electric drill and extension lead

- Selection of steel and masonry drills
- centre punch
- Flashlight
- Lead light
- Selection of coaxial fly leads
- Suitable multimeter – at least 20 000 Ω/V

4.2.6.2 Additional items of test equipment that will prove useful during the installation and testing phase are:

- a) oscilloscope with TV synch capabilities;
- b) Hand held test monitor;
- c) Cable tester;
- d) lux level light meter;
- e) Focal length finder (viewer); and
- f) Electronic focus meter.

4.2.6.3 Site staff should ensure that their tools and equipment are kept in good working order and arrange for regular calibration of their test measuring equipment.

4.3 Environmental considerations

4.3.1 General

Too often, references have been made to the poor live, recorded and play-back quality (lost or distorted information) of CCTV systems. The causes are often blamed mainly on the camera itself, when in fact it is the entire system which needs to be examined and rectified. The camera may be a good place to start when looking for system faults during the installation of a new system, but consideration should also be given to areas such as the lenses, power supplies, cable or transmission types, distances, the switching/multiplexing units, monitors and analogue or digital recording equipment. The optimum performance of all electronic equipment may be (and in most cases is) affected by the environment or conditions in which it is expected to operate, such as:

Weather ----- (Rain, hail, lightning, snow, sleet, wind, dust, heat);
Light ----- (Sunlight, artificial light, reflection of light); and
Interference ----- (Electrical and magnetic).

4.3.2 Weather

Weather conditions affect cameras and any other equipment such as lenses, pan/tilt/zoom (PTZ) units and cables, which are installed outdoors. Southern Africa has a very hostile environment, weather conditions are extreme and in many instances totally unpredictable. It is important that before any outdoor installation takes place, a full understanding of the environment in that area (or region) is taken into account, and that all precautions to prevent equipment damage or interference (or both) with the equipment are made by the person designing the system. The assumptions, made by the designer, should be confirmed by the site installation staff once the work has commenced.

4.3.2.1 Rain, hail and lightning

Cameras, lenses and PTZ units will be affected by rain and hail if not housed in suitable enclosures. Although there is no protection against a direct lightning strike, precautions should be taken to prevent damage to cameras and other CCTV equipment against associated voltage surges, by using the appropriate surge protection device. These devices should be installed at both the camera and control equipment ends. All 220 V a.c. power distribution points feeding CCTV equipment should also be protected against voltage surge at the distribution board and equipment end.

4.3.2.2 Snow, sleet and wind

In areas or regions where CCTV equipment is exposed to snow or sleet, camera housings should be fitted with heaters to prevent misting of the camera housing glass front cover. Wind has a major role in camera instability, especially in the case of the heavier PTZ camera units. Structures (for example, the walls of buildings) should be used to secure cameras to counter the effects of strong winds. If mounting towers are used, then these should be sufficiently rigid to prevent undue influence of the wind on the camera stability.

4.3.2.3 Dust and heat

Protection against dust and heat is also required if these elements present a problem. Dust proof housings, sometimes with additional sealant, should be used. In certain situations it will be necessary to fit a fan inside the camera housing to circulate air or limit dust (or both) from entering the housing. In extreme situations, low pressure compressed air is used to reduce the amount of dust coming into the housing or settling on the housing glass window. In high heat and humid conditions heaters can be used to prevent misting of the glass front cover.

4.3.3 Light

There are two main types of light that affect the picture quality received from the camera, namely, natural light and artificial light. Artificial light is normally constant, whereas natural light changes, depending on the time of day and weather conditions and often without warning. The camera cannot adjust to light or angles of view as well as the human eye can, so allowance has to be made in order to achieve the optimum expected performance of the camera in all conditions. There are different types of cameras and lenses with filters that are designed specifically to handle natural or artificial light (or both). If the lighting or scene illumination is poor, the entire CCTV systems' live, recording and play-back quality will be poor. This aspect would normally be taken care of when the cameras to be provided at the different locations are specified.

4.3.3.1 Natural light

Natural light sources include the sun, moon and stars, and contain most of the colours of the visible spectrum as well as infrared (IR) radiation. Although many CCTV cameras have electronic iris compensation, this is not very effective in the harsh sunlight conditions experienced in Southern Africa. Therefore, outdoor cameras should be fitted with auto iris lenses. In addition, cameras should never face into direct sunlight to avoid silhouetting of the subject. When positioning cameras, both internally and externally, it is important to face the camera to the north or south (wherever possible) so as to avoid the sunlight shining directly into the lens, especially during sunrise and sunset. If it is not possible to avoid direct sunlight, then install the camera higher off the ground or fit the camera in a 'sun shield' type housing (or both), and tilt the front of the camera downward. It is always good practice to install outdoor cameras out of reach of would-be vandals. Lens filters may also be used to reduce the effects of direct sunlight.

4.3.3.2 Artificial light

Artificial lighting is sometimes filtered or mixed with natural lighting coming in through doorways and windows that can present a problem due to the silhouetting of the subject being monitored. In the evening, natural light or sunlight fades, leaving the artificial lighting to illuminate the scene. The problem in this instance is that the areas that appeared to be well lit during daylight hours may well turn out to be poorly lit at night, resulting in poor scene illumination after hours. Additional lighting may need to be installed, which may call for a night visit to the site, in order to determine the illumination requirements. Although artificial lighting levels are generally constant, different types of illumination sources can influence the quality of the picture due to the spectral response of the different lamp types. Whatever the illumination type, it is always preferable to face the camera away from a light source to keep it off the camera face-plate, wherever this is possible.

4.3.3.3 Reflection of light

The reflection of light can distort video images. Light reflecting off vehicle windscreens, white or shiny objects and even tiled floors will contribute towards the silhouetting of the subject that is being viewed. Once again, filters may be used to overcome some of these problems along with the use of camera housings with side shields. However, light reflecting off shiny floors at the inside of the entrance of building doorways seems to

be the most common problem with CCTV installations. Some methods to overcome direct or reflective light problems are:

- Blank off the incoming light by, for example, tinting the glass, or installing an external sunshield above the doors or windows.
- Install additional lighting alongside or behind the camera and face it towards the subject, being careful not to create more reflection from the shiny floor, and also position the lights so as not to blind people walking through the area being monitored.
- Deliberately reflect (or bounce) additional light off the ceiling or walls. This is sometimes a better alternative to the method suggested above as shadows are less obvious and the possibility of blinding or irritating people's eyes is reduced.
- Use infrared (IR) illuminaires – remember to ensure that the camera in use is IR compatible. IR lighting may also be bounced off reflective surfaces such as ceilings and walls.
- Carpet highly reflective or shiny floors wherever practical.
- Use lens filters. Polarizing filters darken a blue sky in the final image without affecting other colours and also reduce reflection from shiny non-metallic surfaces such as glass, water, or varnished wood. Neutral density filters are colourless filters that are available in various degrees of density. They are used to reduce the amount of light reaching the camera's image sensor without otherwise affecting the colours or values in the picture.
- Relocate cameras to alternative positions.
- Use cameras with Back Light Compensation or Automatic Gain Control features (or both).
- Control equipment that has brightness and contrast control, such as digital recording units, can also be used to good effect.

4.3.4 Electrical and magnetic interference

All electronic equipment is sensitive to electrical and magnetic interference and it is advisable to install CCTV equipment away from such sources of interference. If this is not possible, the provision of Intrinsically safe housings may be necessary. However, only protecting the equipment from interference is not enough, all video cables should also be isolated.

4.4 Bench testing

It is a generally accepted practice for systems that incorporate, for example, PTZ units or matrix equipment (or both), for the contractor to pre-build and bench test the video equipment at his premises before dispatching it to site. These tests would check that the equipment conforms to the original specified requirements. Furthermore, these tests are usually witnessed by the client and a test certificate, signed by both parties, is issued. Even if total bench testing is not done, it is recommended that all cameras have their back focus adjustment checked or set before delivery to site (or both). The procedure is to decide the plane of the scene on which the best focus is required and then set the lens focus ring to the mid-position. Then set the camera mechanical adjustment (or back focus) for maximum clarity. Finally, fine focusing can be carried out at site using the lens adjustment ring.

4.5 Site visit

4.5.1 General

4.5.1.1 A pre-installation site visit by the contractor should be made, especially for the larger installations. During this visit the contractual obligations shall be confirmed with the client's representative and the design parameters shall also be checked. A copy of the site/system layout drawings shall be used to confirm each camera position, control equipment location, cable routes, power supply points, etc. Changes to any of these items should be reported to the system designer for approval and revision of the appropriate drawings.

4.5.1.2 This visit shall also be used to arrange a secure storage location for the CCTV equipment, installation material, tools and test equipment. It is generally the responsibility of the installation contractor to ensure the safekeeping of the goods (that is, equipment, etc.) until such time as the client signs the formal acceptance

of its hand-over. For the larger installations, the General Conditions of Contract shall state the liability of each party in terms of the insurance requirement. As a rule, the contractor should insure the goods, as a minimum, against theft or damage during transit and whilst being stored on site. Other insurances in terms of Public Liability, Common Law Liability, Workman's Compensation, Liability for the loss or damage to the client's property, and liability for the bodily injury to or death of a person arising from or in connection with the work, are also normally advisable to obtain.

4.5.2 Camera mounting positions

The site visit may reveal that it is no longer possible to install the camera in the pre-planned mounting position due to obstructions such as building modifications or alterations. In deciding on a new position the installer should ask, inter alia, the following questions:

- What does the user/customer need to see?
- Where are the artificial lights in relation to the camera position?
- Is there any direct sunlight coming into the area to be monitored?
- Is there any reflection of light? Where and what time of the day?

4.5.3 Camera lenses and scene

The designer's camera lens selection and required view will also be confirmed during the site visit. A focal length view finder may be used to confirm the correct lens selection and required field of view. The required scene to be viewed should be documented so that the installer is under no misunderstanding of what is required. An example of a typical camera schedule is given in table 1. This schedule can be adapted to suit the requirements of the installation. For example, instead of a camera description being given, the camera model number could be used, if the actual type of camera has already been chosen.

1	2	3	4	5
Camera number	Description or type	Lens	Location	Coverage
1	Hi-res, colour, 1/3 " 24 VAC	2.8 mm, manual iris	Showroom	Till No. 1
2	Hi-res, colour, 1/3 " 24 VAC	2.8 mm, manual iris	Showroom	Till No. 2
Etc	Etc	Etc	Etc	Etc
8	Phillips	3.5 to 8mm, manual iris varifocal	Main entrance	Looking into the reception lobby
Etc	Etc	Etc	Etc	Etc

Table 1 — Typical camera schedule

4.5.4 Cable routes

All cable routes should be checked and confirmed with the client during the site visit. The following check list is offered as a guideline for this purpose:

- Ensure that the planned video cable routes are not shared by electrical cables, as prescribed by the recommended separation distance between the video cable and the nearest power cables should be a minimum of 1.5 m.
- Cable routes should take the length into consideration so as to avoid unacceptable voltage drops that could impair the effective operation of the video equipment connected to the individual cables. This aspect is covered in more detail in the implementation phase section (see 5.5).
- Ensure that all cable routes are protected from chemicals, sewerage and any other potentially hazardous

substances that may affect the cables in any way.

-Check that any existing conduit has a draw wire, is free of liquids and any other obstruction and is securely fixed.

-If new conduit is to be provided, check the structures that will support it for any signs of structural damage.

-If trenching is required, ensure that there is no conflict with any other existing cable routes, services or by-laws. This is especially important in the case of city or suburban CCTV installations and before approval from the appropriate authorities may be required.

-Cable drops from ceiling to floor should be mechanically protected. The inside of a dry wall partitioning is ideal for this requirement as not only does it protect the cable but it also hides it from view.

-Cables that pass through holes should be adequately protected by the use of tubes or grommets, as appropriate.

4.5.5 Power supply points

The planned power points for the CCTV equipment should be located as near as possible to the equipment they are to power. They should also be dedicated and not shared with other equipment. The power supply requirement at each point should be (230 V $\pm$ 10%)/50 Hz and should have the necessary surge protection device fitted.

4.5.6 Control Point

A control point can range from a simple cupboard or cabinet that houses the CCTV control equipment and a monitor that is viewed by the client (for example a small shop owner), right through to a large control room containing many monitors and a large quantity of control equipment. Irrespective of the size of control point, the cables entering the point or room should be carefully planned to ensure that they enter at the most convenient location in relation to the CCTV equipment. Once again, the video cables should be kept separate from other power and signal cables and protected when passing through entry holes.

5 Implementation phase

5.1 General

This phase can be seen as the actual physical installation of the CCTV surveillance system. However, even at this stage it is unusual for an installation to be completed as originally designed or even as agreed at the pre-installation site visit. Problems concerning cable routes, camera position, lens types, etc. and variations requested by the client will generally occur during the installation period. This phase will often overlap with re-designing and planning changes. The principles and requirements given in the CCTV design standard and in the pre-installation section (see clause 4) of this part of Kenya Standard still apply. Consequently, some of the information given in the following section will be similar to information found in other sections of the document as well as in associated standards.

5.2 Camera and lens installation

5.2.1 Cameras

5.2.1.1 The mechanical fixing of a camera bracket (or all video equipment that requires mounting to a structure) should be carried out as recommended by the manufacturer(s). Adequate fixing of equipment is vital, so it is important to check that the structure that is being drilled into can withstand the camera and lens load before drilling. For a solid wall with plaster covering, ensure that the screw penetrates the plaster and extends into the wall by an adequate amount.

5.2.1.2 Place the camera and lens on the bracket and tighten the bracket screw finger tight. Check the picture on the portable monitor and make sure that the angle of view and focus are acceptable. It is usual for the mechanical focusing (or back focus) of the camera to be undertaken during bench testing of the video equipment at the contractor's premises and, therefore, only fine adjustment, using the lens focus ring, is required on site.

5.2.1.3 It is important to remember that, even though a sharp focused picture may be obtained during daylight, it does not guarantee that the picture will have the same sharp focus at night. The most effective

way to focus a camera for most anticipated poor light conditions is to use an electronic focus meter.

5.2.2 Fixed focal lenses

Screw the lens onto the camera, connect the camera to the portable monitor via a fly lead and adjust the lens focus ring to obtain the sharpest picture possible. An electronic focus meter can also be used. Re-adjust the back focus on the camera if a sharp focus is difficult to achieve.

5.2.3 Varifocal lenses

The procedure to be followed when adjusting varifocal lenses is:

- a) Fit the varifocal lens to the camera and connect the camera to the portable monitor via a fly lead;
- b) Manually zoom all the way into the area to be monitored and focus, zoom all the way out and focus;
- c) If the focus is still not clear, use the back focus adjustment on the camera until a sharp focus is obtained;
- d) Repeat this and double-check zoomed-in and zoomed-out focus before selecting the required angle of view; and
- e) Zoom to the required angle of view and gently lock the lens focus and zoom screws finger tight.

5.2.4 Manual and motorized zoom lenses

5.2.4.1 It is essential that the mechanical or back focus of the lens is set correctly as this is the most frequent reason for the focus changing when zooming. Zoom lenses have various settings between telephoto (or "far") and wide angle (or "near"). These two positions are used when the camera is focused in its operating position. The following steps should be taken to focus the lens:

- a) Aim the camera at an object approximately 40 m away;
- b) set the focus ring to "far", making sure that the iris is wide open (so that focusing is most critical), and set the zoom ring to the widest angle of view;
- c) Adjust the camera back focus for maximum clarity;
- d) Next, zoom to a nearby object and set the lens focus for maximum clarity; and
- e) It should now be possible to zoom all the way back without the focus changing.

5.2.4.2 Many motorized lenses will be used in external conditions with limited light. If this is the case, then it is advisable to fit a neutral density filter in front of the lens to make sure the iris is open fully. A neutral density filter is a filter that reduces the amount of light that enters the lens evenly over the whole of the visible spectrum. This will create the shortest depth of field and ensure setting up more accurately for the worst conditions.

5.2.4.3 There are many situations in which motorized zoom lenses with preset (or predetermined) positions are used. In this mode of operation the zoom and focus ring positions are monitored electronically and memorized by the CCTV control system during set-up. They are then automatically repeated on command by the control system at a later stage. These preset positions need to be agreed with the client and set as part of the control point installation.

5.2.5 Handling of cameras and lenses

It is important to handle all CCTV equipment, especially cameras and lenses, carefully. The following guidelines are recommended as best practice:

- a) Protect cameras and lenses from knocks or vibration (or both);
- b) Remove dust from cameras and lenses with a soft brush, avoiding touching of the lens surface;
- c) Remove finger prints or oil stains on the lens surface using lens cleaning paper or clean cotton cloth with a little cleaning liquid. Wipe lightly, starting from the centre of the lens surface;

- d) Wipe the camera and lens body only with a silicon cloth;
- e) Avoid using any organic solvents such as thinners or benzene;
- f) For health reasons, avoid looking through lenses into direct sunlight; and
- g) Avoid facing cameras directly into sunlight as this can damage the Image Device.

5.3 Video transmission

5.3.1 General

Video signal transmission is a key component in any CCTV system. Most systems use coaxial cables, but fibre-optic cable is fast gaining acceptance due to its better picture quality (especially with colour) and the lower risk factor with respect to ground loops and electrical interference. Other techniques, such as microwave and infrared, are also available. A brief overview of the different transmission mediums is given in 5.3.2 to 5.3.7.

5.3.2 Coaxial cable

Coaxial cable, type RG 59, is the most widely used video transmission medium for short to medium distances (i.e. up to approximately 300 m). For distances up to 900 m, coaxial cable type RG 11 shall be used. These types of cables have a single conductor with a characteristic impedance of 75 Ω , and the video signal is applied between the centre conductors and a coaxial braided or foil shield. Cables come in many different mechanical formats; including single wire armoured and irradiated PVC sheathed cable for direct burial. Cables are also available with different performance ranges, from relatively poor to excellent. Performance is normally measured in high frequency loss per 100 m. The lower the loss figure, the less distortion of the video signal. Therefore, higher quality cables should be used when transmitting the signal over long distances.

5.3.3 Twisted pair cable

The primary purpose of using balanced twisted pair cables is to increase the transmission range and to eliminate the picture degradation found in some coaxial applications. Advantages of using twisted pair cables include:

- a) The ability to reject unwanted interference;
- b) Lower losses at high frequencies per unit length;
- c) Smaller size;
- d) Availability of multipair cables; and
- e) Lower cost.

However, the advantages shall be considered in relation to the cost of the additional equipment required for this type of transmission. A launch amplifier to convert the video signal at the camera end and an equalizing amplifier to reconstruct the signal at the control end are needed.

5.3.4 Microwave

Microwave systems are radio systems using frequencies in the gigahertz range and, therefore, require an unobstructed line of sight transmission path. Any metallic or wet objects in the transmission path cause severe attenuation and reflection, often, rendering the system useless. Even when a line of sight path exists, there can be signal fading, primarily caused by changes in atmospheric conditions between transmitter and receiver units. Normally there is one transmitter and one receiver for each camera which makes this type of transmission system expensive. In addition, licensing by the relevant authorities is required. However, when it is not possible to make a direct cable connection between the camera(s) and the control position, and especially when real time continuous monitoring is required, this method of video transmission can be considered.

One of the newest methods of video transmission is the infrared link. Infrared can be used to transmit video signal over long distances and is unaffected by all forms of electromagnetic interference. Although infrared links offer a cost-effective method of free space transmission with no licensing requirement, they do require a clear line of sight and are affected by adverse weather conditions and certain environmental conditions such as smoke.

5.3.6 Fibre-optic

In fibre-optic transmission the video signal is converted from electrical impulses into pulses of light that are then sent down a glass optical fibre. Fibre-optic links offer quality signal transmission, reliability and immunity from electromagnetic interference. Fibre-optic transmitters and receivers are required to convert electrical signals to light signals and *vice versa*. In addition, the fibre-optic cable has to be terminated correctly to ensure optimum operation. With this method of transmission, the multiplexing of video signals with data and audio signals travelling in opposite directions simultaneously is possible. This makes fibre-optic very suitable for pan/tilt and zoom applications. Two common types of fibres are used for CCTV installations, namely:

-Single-mode – small in diameter, producing few reflections of light and used for long transmission runs of many kilometres.

-Multi-mode graded index – larger diameter, producing many reflections of light, and used extensively in CCTV security applications.

The advantages of using a fibre-optic transmission system include:

- a) Complete electrical isolation between the camera and related equipment from the control end, that is, the monitor, recorder, printer, etc;
- b) Immunity from radio frequency and electromagnetic induction interference;
- c) Inherent transmission security;
- d) No fire hazards;
- e) Absence of crosstalk; and
- f) No radiation of radio frequency and electromagnetic induction interference.

5.3.7 Selection of appropriate video transmission system

The most economical and most common method of video transmission is coaxial cable. For distribution within a building or short cable runs (up to 300 m) from camera sites, RG 59 cable is commonly used. For longer runs (up to 900 m), RG 11 cable is used. Due to cable characteristics, the higher frequencies are attenuated (video signal loss) and it may be necessary to install equalizing equipment to restore resolution and contrast on long lengths of cables. In addition, it may also be necessary to provide a video amplifier to boost the video signal level when the distance exceeds the recommended cable length. This amplifier is normally installed at the camera location. As an alternative to using coaxial cables on long runs, balanced twisted pair cables can be utilized quite successfully.

In applications where running of cables is not desirable or feasible and a line of sight path is present, an infrared or microwave system may be used. Different models are available based on cost, path distance, and frequency band. In most instances a licence will also be required. If a cable may be used and coaxial cable is not a good choice due to distance, conduit space, interference, ground loops, or security signal concerns, then a multi-mode graded index fibre-optic cable transmission system can be used. Fibre-optic equipment is cost sensitive to the distance and each transmission path should be analysed to optimize the design.

5.4 Installation of coaxial cables

5.4.1 As previously stated, the most common of all video transmission systems installed is coaxial cable. This cable should only be used in areas where the cameras and control equipment are in near proximity of each other, i.e. not more than 300 m for RG 59 and not more than 900 m for RG 11.

5.4.2 When installing a coaxial cable in a hostile environment, where there is a risk of corrosion, excessive heat, strong sunlight, dampness, or a risk of mechanical or chemical damage, it should be installed in protective sleeves such as conduits or ducts for protection (or both).

5.4.3 Cables that pass through holes should be adequately protected by means of tubes, sprags, or grommets.

5.4.4 Cable drops from ceiling to floor should be mechanically protected.

5.4.5 When pulling coaxial cable through conduit, the outer earth cable should be attached to the "pull through" so as to prevent the centre core from being stretched or broken (or both).

5.4.6 Coaxial strippers should be used for cutting and preparing the ends of the coaxial cable. Using a knife or any other tool is not recommended due to the risk of damage to the cable and possibly the individual.

5.4.7 Crimping the BNC connector onto the coaxial cable should also be carried out with the use of a crimping tool and not a pair of pliers. The centre core should be crimped as well as the outer BNC sleeve. Loose earth wires should be cut away from the BNC connection and a rubber boot or sheath should be used to make for a clean, aesthetically pleasing, and protected joint.

5.4.8 The unobtrusive marking of each individual cable at both ends (i.e. the camera and the control point), is essential to facilitate easy and time saving connection to the control equipment, as well as future maintenance and servicing needs. The marking of the cables near the exit point in a ceiling void is particularly beneficial when tracing cables in the future. The use of alphanumeric tags or printed/heat shrink cable markers is recommended.

5.4.9 In the case of solder on BNC connectors, ensure that the soldered joint is clean in order to prevent signal loss. The importance of clean connections cannot be overstated.

5.4.10 When using steel-wire armoured cable, the steel wire should be earthed at each end of the cable run.

5.4.11 It is important to remember that each part of the installation shall be carried out correctly so that the optimum expected performance of the equipment may be reached or achieved.

5.4.12 It is recommended that the jointing of cables should not be carried out under normal circumstances. Should jointing be absolutely necessary, then this should be carried out using BNC connectors.

5.5 Power supply installation considerations

5.5.1 CCTV equipment operates from either an alternating current (a.c.) or direct current (d.c.) power source. The power source type and voltage level used depend on the equipment chosen and the application intended. By far the most convenient power source available for the majority of CCTV equipment is the 230V a.c., 50 Hz mains supply. When it is necessary to locate equipment remotely from the power source, it is often convenient to use 24V a.c. equipment and reduce the voltage to 24V a.c. via a step-down transformer. The main advantage of using a 24 V a.c. power source, apart from the obvious safety reasons, is that the power source can be fitted by anyone and a qualified electrician (that is, one holding a wireman's licence) is not necessary. If equipment is designed for use with a d.c. power source, such as some CCD cameras or small covert type cameras, then a 12 V d.c. power source is used, i.e. one 12 V d.c. power supply per camera. This can be derived from an a.c. source using an a.c. to d.c. converter or power supply, or from a battery.

5.5.2 All wires and cables associated with the distribution network, shall have the insulation, voltage breakdown, and physical characteristics suitable for the voltage, current, power, and environment in which they will be used. In addition, they shall meet the fire and safety standards of the local authority.

5.5.3 When a single item of equipment is connected to the power supply output, the conductor size, i.e., the wire diameter shall be sufficiently large so that no significant voltage drop occurs between the power supply and the equipment that could result in too low a voltage being available at the equipment.

It is normal practice to connect equipment in parallel across the power source. If this is the case, it is important to ensure that the equipment at the end of the power line receives the minimum rated voltage for that particular item of equipment.

5.5.4 For safety reasons and to keep extraneous noise from contaminating signals, electrical power cables shall be run in a separate conduit or trunking and not in the same conduit or trunking as the signal cables. The reason for this is that the power cables are manufactured with insulation resistance sufficient to withstand the higher voltages used in power systems, whereas the signal cables usually have insulation sufficient for voltages up to approximately 100 V. Thus the physical separation of the two types of cables will prevent accidental short circuiting.

5.5.5 Any jointing of power cables should be made within a junction box. Only ferrule or lug type connections should be used for terminating of the cables.

5.5.6 Uninterruptible power supply (UPS) equipment is categorized by output power capacity and generally configured for continuous duty or standby operation. The power is supplied continuously to the load by a device called a static converter, which obtains its power from a storage battery. The battery charges itself continuously through the incoming power line. A decision should be made, preferably during the operational requirements phase, as to whether or not the proposed CCTV system has any essential camera, monitor, or recording equipment that shall continue operating in the event of a power failure. If so, then an UPS system must be provided. It is recommended that the design and installation of this type of system be carried out by a qualified electrical engineer.

5.5.7 Another important aspect of the electrical distribution system is the use of good earthing practices and the elimination or avoidance of earth loops in the system. The finite resistance, inductance and capacitance of conductors carrying these earth-loop currents, provide common cross-coupling impedance that may inject unwanted signals, noise and crosstalk into sensitive input circuits.

5.5.8 To achieve noise-free CCTV image performance, the following installation practices are recommended:

- a) Ensure that proper grounding is in place;
- b) Coaxial cables should be terminated at both ends;
- c) Equipment chassis and cable shields should never be used for signal-return paths, except when coaxial cables are used;
- d) Signal circuits should use balanced cable such as twisted pairs or shielded or balanced coaxial lines;
- e) Individual shields of balanced coaxial cables, when contained by a common shield, should be insulated from one another and from the common shield;
- f) Cables that carry high-level signals should not be bundled with cables carrying low-level signals, whether shielded or not;
- g) Each signal cable should have its own independent return line running as close as possible to the signal line, thus reducing the loop area; and
- h) Use twisted-pair cable (signal and return lines together) to ensure a minimum pickup-loop area.

5.6 Surge protection

5.6.1 General

Surges can enter electronic equipment through the power or through the signal cables (or both). Since it is easy to identify the points of surge entry, the location for the fitting of surge protective devices (SPDs) can also be easily ascertained by the installer.

5.6.2 Typical surge protection devices

Metal oxide varistors (MOVs) are quite adequate for the protection of the mains connected equipment. However, electronics are characterized by a small difference between the normal circuit operating voltage and the voltage capable of causing damage and therefore, the protection device must clamp the voltage between the signal lines and the signal reference conductor – the silicon suppressor (usually referred to by its trade name “Transzorb”) is normally used in this situation. The problem with this type of suppressor is its limited surge energy absorption capability; therefore, additional components are required in the form of a spark gap device and a series impedance device. The function of the impedance is to limit the current through the silicon suppressor both before the spark gap has operated (the spark gap does not operate instantaneously due to inherent delays in the creation of the arc – could be microseconds) and after the spark gap has operated (the arc voltage can be as much as 30 V).

5.6.3 Installation

Ideally, the spark gap device should be located at the building entrance where both the cable entry point and the earth bar are situated. The advantages of this position are that the surge currents are diverted as soon as possible and the large magnitude magnetic fields associated with the surge current are kept away from the sensitive electronic equipment. For many situations this spark gap position is not feasible and, therefore, the closest protective earth is used.

Typically, the mains electrical network should be protected at the first point of entry of the cable by a 40 kA, 3-phase and neutral SPD. Any distribution board more than 10 m in distance from the first point of entry should also have the 40 kA SPD for 3-phase and neutral installed or a 40 kA SPD for single phase and neutral. However, if the distribution boards are less than 10 m from the mains supply, a 6.5 kA SPD for 3-phase or single phase and neutral will be sufficient. The SPD used to protect the electronic equipment shall depend on the type of inputs into the equipment, such as telephone lines, antenna cables, or other input types. Lightning and surge protection is a specialized area of expertise and it is recommended that the appropriate individuals or companies (or both) that are proficient in this type of protection be approached for design assistance.

5.7 Ancillary field equipment**5.7.1 General**

This section gives recommended guidelines when installing typical ancillary CCTV field equipment. Only the most commonly used equipment and installation situations are dealt with.

5.7.2 Ceiling mounted dome housings

- Ensure that there is enough space for the camera and cables between the artificial ceiling and the actual concrete ceiling.
- Mark off the area where the hole is going to be cut with the correct template.
- Fit the camera into the dome bracket, following the manufacturer's installation instructions.
- Fit the dome bracket to the false ceiling.
- Focus the camera and set the iris position using the portable monitor.
- Place the dome housing cover onto the dome bracket, being careful not to scratch or dirty the dome housing cover.
- After fitting the cover on the bracket, check for picture quality, using the portable monitor.
- When using mirror domes, ensure that the selected lens can go down two F-stops.

5.7.3 Internal and external housings

Internal housings protect the camera and lens from tampering and are usually made of light-weight material. External housings protect the camera from the environment, such as extremes of heat, rain, dust, and dirt, as well as from tampering. In both types of housings, however,

- a) The lens of the camera should be as close to the front glass as possible to eliminate side view interference caused by the actual housing enclosure, and
- b) The housings should be mounted on suitable brackets.

5.7.4 Internal camera brackets

- Ensure that the bracket can adequately support the weight of the camera, lens and housing (if required).
- Ensure that there are no hidden cables.
- Ensure that the supporting structure can support the bracket and camera.
- Ensure that the running cable to the selected camera position is possible without causing damage or inconvenience to other current or future installations.
- When selecting the bracket position, consider future maintenance to the camera and accessories.

5.7.5 External camera brackets

In addition to the requirements detailed for internal bracket installations, the following should also be considered:

- a) Ensure that the bracket is suitable for the environmental conditions expected;
- b) Keep bracket (equipment) out of general reach; and
- c) Protect as far as possible all equipment associated with the bracket, including cables, against vandalism.

5.7.6 Pan and tilt mechanisms

There are two main types of pan and tilt units. The first is a unit where the camera or housing is mounted directly on a platform that forms part of the construction – either mounted on top of the platform or mounted on the side. The second type of unit is where the driving components are contained within the same enclosure as the camera, such as dome housing. Indoor units are, in general, light-weight and require no environmental protection – dome units are ideal for use in this application. External housings, however, have to contend with much harsher environmental conditions, such as wind, rain, dust, dirt, corrosion, temperature extremes, humidity, and higher levels of vandalism. To successfully cope with these additional burdens, the pan and tilt mechanisms should be more rugged and environmentally resistant. It is recommended that this type of equipment be installed strictly in accordance with the instructions of the relevant supplier or manufacturer.

5.8 Control point installation

The design of control point installations is covered extensively in the standard on system design requirements. Control point equipment shall include, inter alia, the CCTV control equipment, monitors, switchers, multiplexers, VCRs, digital storage equipment, printers and matrices, etc. This equipment should be installed and set up in accordance with the relevant manufacturer's instructions.

6 Documentation

6.1 The CCTV system documentation will include both drawings, and operating and maintenance manuals. The installer may not be responsible for all aspects of the documentation but will need to provide, as a minimum, "As built" drawings and possibly some of the test results. The size of the installation will normally determine the amount of documentation required and the person responsible for the supply of such documentation. It is recommended that the documentation requirements in 6.2 be used as a checklist to ensure that sufficient documentation is provided to allow for the correct operation, maintenance and future expansion of the system.

6.2 Preferably, the manuals should be bound in book form with hard plastic covers to withstand constant use, be

properly indexed to facilitate easy reference and include the following information:

- a) A list of spares to be supplied by the installer/contractor to cover the period of maintenance;
- b) A list giving the name and address of the local agent for each item of equipment;
- c) A list giving the name and address of the manufacturer of each item of equipment;
- d) Copies of all test certificates obtained for the system;
- e) A preventative maintenance programme for all equipment;
- f) Operating instructions for each item of equipment;
- g) Complete "As built" drawings of the installation and wiring and schematic diagrams;
- h) Detailed operating instructions for all the modes of operation of the system;
- i) Take-over certificate; and
- j) Test and commissioning data sheets.

7 Pre-commissioning testing

7.1 The size and complexity of the CCTV system shall determine the amount of involvement of the local site installer. For simple systems, the installer may be required to test and commission the system before handing over to the client. On the other hand, another individual in a more formal manner shall possibly commission larger complex systems.

7.2 Irrespective of the complexity of the system, it will need to be checked electrically, mechanically (or functional testing) and visually to ensure that it conforms fully to the system specification. The functional test would check the functional compatibility of the components of the installation against the operational requirements and the system specification. The visual check would cover the standard of workmanship of the installation, the functional quality of the equipment and its compliance with the system specification.

7.3 As a minimum, the installer may be required to assist with some or all of the following tests or checks:

- a) Check if all wiring is correctly terminated;
- b) Check the continuity of all circuit wiring;
- c) Check the insulation between conductors and record results;
- d) Check and record supply voltages at all equipment;
- e) Check and record normal light levels in each area (a lux light meter may be used for this purpose);
- f) Record camera type and lens details for each position;
- g) Check that all auto-iris lenses operate under varying light levels;
- h) Check the settings of all pan, tilt and zoom units;
- i) Check that all supplementary lighting is operational;
- j) Remove mains supply and ensure that the system works in the standby mode (if specified);
- k) Check that the same phase of the mains power is used for all cameras (if a requirement); and
- l) Ensure that all system documentation is provided and the information correct.

7.4 In general, the testing aspect is concerned with the checking of individual items of equipment, wiring and

cabling to ensure that they comply with the various individual specifications and appropriate good practice, whereas commissioning is concerned with the functional operation of the system as a whole to ensure that every function and camera view is as specified.

It is recommended that a formal specification and procedure be established for the inspection, testing and commissioning phase of the CCTV project

7.5 On successful commissioning of the system, in terms of the specified requirements, a formal hand-over to the client takes place using a "Take-over Certificate". It is this certificate that provides the written notification to the installer that the client has taken over the system in terms of the contract. Final contract payments and equipment guarantees are normally linked to the date of this certificate, hence the importance of this final phase of the installation process.

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